Buildings for the 21st Century

Buildings that are more energy efficient, comfortable, and affordable…that's the goal of DOE's Office of Building Technology, State and Community Programs (BTS). To accelerate the development and wide application of energy efficiency measures, BTS:

- Conducts R&D on technologies and concepts for energy efficiency, working closely with the building industry and with manufacturers of materials, equipment, and appliances
- Promotes energy/money saving opportunities to both builders and buyers of homes and commercial buildings
- Works with state and local regulatory groups to improve building codes, appliance standards, and guidelines for efficient energy use
- Provides support and grants to states and communities for deployment of energy-efficient technologies and practices

SLAB INSULATION

Improve comfort and save energy in homes with slab-on-grade floors

SLAB-ON-GRADE FLOORS PROVIDE AN INEXPENSIVE AND VERSATILE FOUNDATION

Slab-on-grade floors are often the least expensive foundation system and can expedite the construction process. The foundation consists of a concrete slab poured over at least 4 inches of gravel and a layer of 10-mil polyethylene. Virtually any floor covering works well with a slab, although wood flooring systems may require installation of wooden furring strips prior to attaching the wood flooring material.

Homes use slab-on-grade floors in two ways: either as the bottom floor of a home or as the floor in a daylight basement—where the floor level is about even with outside earth. Areas with mild winters do not require a deep foundation. In these regions, slab-on-grade foundations may prove an ideal choice for flat lots.

Care must be taken in designing a home with a slab foundation to avoid a "squat" appearance. For example, porches are at grade level in houses with a slab foundation, rather than being elevated above the yard. The hard surface of the slab foundation may cause injuries, more frequent breakage of dropped objects, and tired feet unless it is covered with carpeting or other softer floor finishes. Use of slab foundations can also make it more difficult to install wiring, plumbing, and ductwork, so the design of these systems into the construction plans and process is essential.

BENEFITS OF INSULATING SLAB-ON-GRADE FLOORS

Slabs lose energy primarily as a result of heat conducted outward and through the perimeter of the slab. In most sections of the country, insulating the exterior edge of the slab can reduce winter heating bills by 10 to 20 percent.

SLAB INSULATION

Provides a thermal break to the perimeter of slab-on-grade foundations.

In climates with mild winters, slab insulation in a typical 1,800 square-foot home would save $50 to $60 annually. R-10 slab insulation for an 1,800 square-foot home would typically cost $300 to $600 to install. Thus, the insulation would pay for itself in 5 to 10 years.

The investment in slab insulation is also economical when it is part of the mortgage. An insulation cost of $450 would add about $38 to the annual mortgage. Since the insulation saves over $50 per year on energy bills, savings exceed the extra mortgage costs and the investment in slab insulation pays off from the beginning.

Slab insulation is important not only to save on energy bills, but also to improve comfort. Cold concrete slabs are one of the most notorious sources of discomfort in a home. Installing slab insulation around the perimeter of the slab will reduce heat loss and make the slab easier to heat. An insulated slab also provides thermal mass to store heat and moderates indoor temperatures.

SLAB INSULATION TECHNIQUES

Slab insulation can be installed following one of two basic techniques: installing rigid insulation directly against the exterior of the slab and footing or building a "contained" or "floating" slab with interior insulation. Whichever design is followed, the keys to an effective slab foundation are:

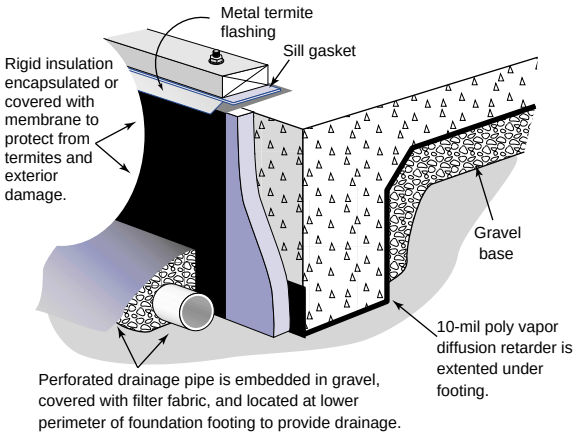
Moisture control—using a water-managed foundation system to drain rainwater and groundwater away from the foundation.

Airtight construction—sealing interfaces between the slab foundation and the exterior wall to reduce infiltration into the house.

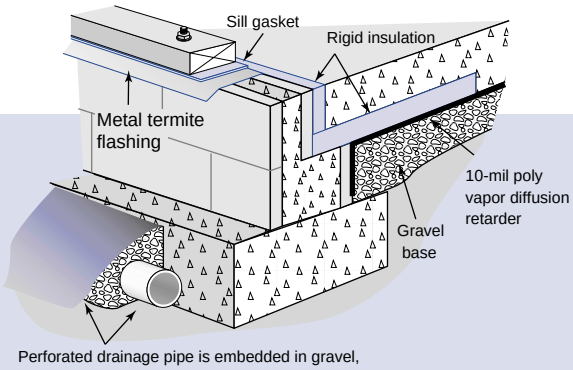
Complete insulation coverage—properly installing the correct insulation levels and making sure the insulation coverage is continuous and complete.

PERIMETER INSULATION—SLAB-ON-GRADE CONSTRUCTION

Provide good drainage away from the foundation and capillary breaks for a durable foundation. Perimeter insulation increases comfort in the living space.



FLOATING SLAB-ON-GRADE CONSTRUCTION



MOISTURE AND AIR LEAKAGE CONTROL

1. Keep all untreated wood materials away from the earth.
2. Install well-designed guttering and downspouts that are connected to a drainage system diverting rainwater completely away from the house.
3. Slope the earth away from the house for at least 5 feet at a minimum 5% grade (3 inches in 5 feet). Establish drainage swales as needed to direct rainwater around the house.
4. Add a sill gasket membrane between the slab and bottom plate to provide air sealing.
5. Install a protective membrane (such as rubberized roofing material or ice-dam protection membranes) to serve as a capillary break that reduces wicking of water up from the foundation. This membrane can also serve as a termite shield.
6. Install a foundation drain directly beside the bottom of the footing. The foundation drain assembly includes a filter fabric, gravel, and a perforated plastic drain pipe typically 4 inches in diameter. Locate the drain beside the footing, not on top, to avoid water flowing against the seam between the footing and the foundation wall and prevent wicking from a web footing through the stem wall.
7. Install a capillary break and moisture barrier under the slab floor, consisting of a layer of 10-mil polyethylene placed over at least 4 inches of gravel.

INSULATION

1. Review the plan for slab insulation with pest control and local building officials to ensure code compliance.
2. Select insulation levels in accordance with the International Energy Conservation Code (IECC) or DOE Insulation Fact Sheet. The Insulation Fact Sheet (DOE/CE-0180) can be ordered from the Energy Efficiency and Renewable Energy Clearinghouse or accessed from the Internet at www.ornl.gov/roofs+walls.
3. Install rigid insulation using one of the two general designs shown to achieve complete insulation coverage of the slab perimeter. Use only insulation approved for below-grade use.

R-VALUES AND RECOMMENDED DEPTH FOR SLAB INSULATION

The IECC specifies both the R-value of the slab insulation and the minimum distance for the insulation from the top of the slab downward based on a locality's Heating Degree Days (HDDs):

Heating Degree Days	Feet Installed Vertically	R-value of Slab Insulation
0 to 2,499	none required	
2,499 to 4,500	2 feet	R-4
4,500 to 6,000	2 feet	R-5
6,000 to 7,200	4 feet	R-6
7,200 to 8,700	4 feet	R-7
8,700 to 10,000	4 feet	R-8
10,000 to 12,400	4 feet	R-9
12,400 to 14,000	4 feet	R-10

HDD=Heating Degree Days

(Consult your local weather bureau for your city's actual annual Heating Degree Days.) Heating Degree Days is a term used to help indicate the heating needed for any certain day. This method is commonly used to determine fuel consumption and/or the cost of heating during a season by using historical weather trends to calculate average seasonal temperatures.

4. If insulation is installed on the exterior of the slab:
   - The insulation should be installed from the top of the slab to the bottom of the frost line unless a termite inspection gap is required.
   - Encapsulate or cover the exterior face of the insulation with a protective membrane to serve as a capillary break and to protect the insulation from termites.
   - Cover the above-grade portion of the insulation exposed to outside air using a stucco coating, pressure-treated wood, brick, or aluminum flashing. When covering insulation, be conscious of how to detect termites in areas prone to termite infestation. Some states in termite-prone areas have addressed this issue by requiring a termite inspection gap near the top of the slab insulation.

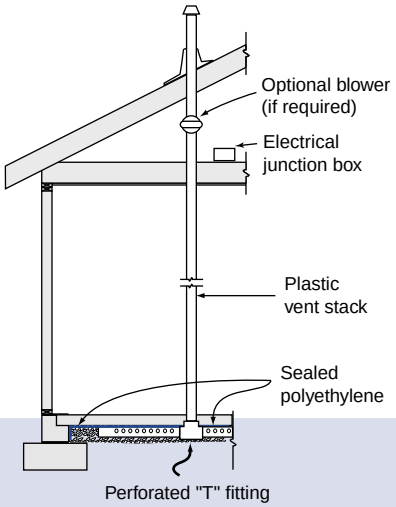
BUILD IN RADON RESISTANCE WHEN INSTALLING SLAB-ON-GRADE FOUNDATIONS

Radon is a radioactive gas that occurs in some soils. It can enter a home through the foundation and floor system. If it occurs in significant concentrations (greater than 4 pico-curies per liter), it may pose a severe health risk to the home occupants. To guard against radon problems in concrete slabs:

- Use a 4- to 6-inch gravel base and a continuous layer of 10-mil polyethylene on top of the gravel.
- Install a tee below the polyethylene that protrudes through the polyethylene and extends above the poured floor height.
- Connect the tee to a 3-inch vertical plastic pipe that extends to the roof through an interior wall.
- Pour the slab and seal all slab joints with caulk.
- Have an electrician stub-in a junction box in the attic.
- Test the bottom-most conditioned room for radon with an EPA-listed radon test kit, or hire a qualified technician. If the house has a high radon concentration, install an active radon mitigation system by attaching a small blower to the plastic pipe in the attic to expel the gasses to the outside.
- If radon levels are especially high (over 25 pico-curies per liter), consult with local radon experts.

RADON-RESISTANT CONSTRUCTION

Passive radon-resistant construction is an inexpensive first cost. It can easily be upgraded if active mitigation is later required to cure a radon problem.



SLAB INSULATION

For more information, contact:

Energy Efficiency and Renewable Energy Clearinghouse (EREC)
1-800-DOE-3732
www.eren.doe.gov

Or visit the BTS Web site at www.eren.doe.gov/buildings

Or refer to the Builder's Guide
Energy Efficient Building Association, Inc.
651-268-7585
www.eeba.org

Written and prepared for the U.S. Department of Energy by:

Southface Energy Institute
404-872-3549
www.southface.org

U.S. Department of Energy's Oak Ridge National Laboratory
Buildings Technology Center
423-574-5178
www.ornl.gov/ORNL/BTC

The International Energy Conservation Code can be obtained from the International Code Council by calling 703-931-4533
www.intlcode.org

MECcheck, a companion compliance software package, can be ordered from DOE by calling 1-800-270-CODE or from the Web at www.energycodes.org/resid/resid.htm.

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SPECIAL REQUIREMENTS OF SLAB INSULATION FOR TERMITE CONTROL

Over the past decade, reports of termite infestations in homes with exterior slab insulation have become more frequent. These pests tunnel undetected through the insulation to gain access to the wood framing in the walls. Some insurance companies no longer guarantee homes with slab insulation against termite damage. Recent rulings by national code organizations, such as the International Code Council, prohibit installing foam insulation in contact with the ground in several southern states (South Carolina, Florida, Georgia, Alabama, Mississippi, Louisiana, Arkansas, and Texas).

An alternative to slab edge insulation is to create a contained or floating slab with interior foam insulation. This non-monolithic approach provides termite resistance because the insulation is sealed within the slab. However, builders in the Southeast United States recently reported termite infestations through foam insulation on contained slabs.

Termite prevention is a key goal when installing slab insulation, especially where a visual inspection of the foundation is not possible. The key to controlling termites is proper treatment, a regular inspection policy, and a strong warranty from a termite company. Before construction, confer with a pest control company to ensure a favorable termite contract.

✓ FOLLOW THESE GUIDELINES TO OFFSET TERMITE PROBLEMS:

- Provide effective moisture control systems.
- Remove all wood from around the foundation before backfilling.
- Install termite shields continuously under the sill plate of the building. While not 100 percent effective, the termite shield may deter or delay widespread infestation and may also force termites into an exposed area where they can be detected. It should project beyond the sill plate and all other portions of the exterior wall. A continuous layer of a membrane such as rubberized roofing material used in commercial buildings may be used as an alternative to the termite shield.
- Use a foam insulation with a termiticide. Usually a derivative of boric acid, the termiticide should pose no more threat to home owners than traditional termite treatments. One of the nation's leading foam insulation manufacturers is planning to offer a termite-treated insulation board on the market in the year 2000 or 2001.

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